Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8225

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2020) *8*(4), 209-214

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Influence of Different Levels of Nitrogen and Spacing on Growth, Yield and Quality of Garlic (*Allium sativum* L.) cv. G-1

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Received: 15.06.2020 | Revised: 18.07.2020 | Accepted: 26.07.2020

ABSTRACT

The results of study clearly shown that 140 kg N/ha significantly increased all the growth parameters (plant height, number of leaves, length of leaves), yield attributes (weight of bulb, bulb diameter, number of cloves etc.) and TSS content of Garlic bulbs.Similarly, wider spacing 20×10 cm significantly increased growth and yield parameters of garlic and followed by 15×10 cm.The interactive effect of nitrogen 140kg N/ha along with 20×10 cm spacing were found significantly superior with respect to weight of bulb (38.07 and 32.35 g), yield kg per plot (4.05 and 3.69 kg) and yield q ha^{-1} (133.05 and 115.85 q/ha), respectively .Maximum net returns (Rs.164896 and 140120) and B:C ratio (4.75 and 4.04) were obtained when higher dose of nitrogen 140 kg N/ha along with 20×10 cm spacing (T_9-N_3S_3), followed by treatment T_6-N_2S_3 (100kg N/ha with 15×10 cm spacing), respectively.Further, it may be concluded that sowing of garlic cv. G-1 application of 140 kg N ha^{-1} along with 20×10 cm spacing can be used in nitrogen deficient soils of Kota region to get significantly better yield, net return and B:C ratio. Otherwise in normal soils of Rajasthan 100 kg N ha^{-1} along with 15×10 cm spacing would be recommended for better yield.

Keywords: *Spacing, Chemical fertilizers, Yield, Quality and Garlic*

INTRODUCTION

Garlic (*Allium sativum*) is an important crop. It is mainly used for flavouring and seasoning vegetables and meat dishes. Madhya Pradesh, Gujarat, Orissa, Maharashtra, Uttar Pradesh and Rajasthan are major garlic-growing states. More than 50% production, however, comes from Madhya Pradesh and Gujarat only. The area, production and productivity and per capita availability of garlic have improved considerably. The total produce as of 2018-2019 recorded in the reports is 188.61 tonnes of garlic. Overall, the share is 17.13%. Rajasthan recorded the highest production of garlic across India in financial year 2018, amounting to over 727.50 thousand metric tons (Dr. P.K. Gupta Annual report 2017-18, NHRDF).

Cite this article: Kumar, L., Meena, R.K., Trivedi, S.K., & Singh, M.J. (2020). Influence of Different Levels of Nitrogen and Spacing on Growth, Yield and Quality of Garlic (*Allium sativum* L.) cv. G-1, *Ind. J. Pure App. Biosci. 8*(4), 209-214. doi: http://dx.doi.org/10.18782/2582-2845.8225

Northern states Uttar Pradesh, Gujarat and Punjab followed. The country produced over 1.1 million metric tons of the seasoning herb that year.Indore and Mandsour in Madhya Pradesh, Angul in Orissa, Junnar Taluka in Maharashtra, Mainpuri, Eta and Etawa in Uttar Pradesh, Sikar, Jhunjhunu, Ajmer and Udaipur in Rajasthan are major garlic-growing pockets. Nutritive composition of fresh by peeled garlic cloves and dehydrated garlic powder is as follows: Moisture 62.80% in fresh peeled garlic cloves and garlic powder moisture is5.20%, protein 6.30% & 17.50 in fresh peeled cloves and garlic powder, and carbohydrates 29.00 % & 71.40 % found in fresh peeled cloves and garlic powder. In fresh peeled cloves energy content is 145.00 K. cal., calcium 0.03 % & 0.10%, phosphorus 0.30% & 0.42, potassium content in garlic powder is 0.70%, mg(mg/100g)71.00%, iron in fresh peeled cloves and garlic powder is 0.001% & 0.004%, vitamin C (mg/100g) is 13.00% & 12.00% in fresh peeled cloves and garlic powder, vitamin B(mg/100g) 16.00% & 0.68% in fresh peeled cloves and garlic powder, thiamine (mg/100g) . The growth and yield of the garlic crop are governed by several factors out of them the spacing play the most important role for case of garlic proper spacing is an important factor. If plants are closely planted, it resulted in competition for fertilizer water and sunlight etc. causes poor growth of plants whereas, wider spacing results in wastage of valuable space, therefore it essential to know the proper spacing and requirement of fertilizer doses of any crop or variety under a particular soil and agro-climatic conditions. Nitrogen and spacing are inter- relatedand affect the plant development yield. Therefor information on proper level of nitrogen and spacing for obtaining maximum yield of good quality is required by growers. Ample research work has been reported on garlic for production of large sized and good quality cloves (Naruka et al., (2005).

MATERIALS AND METHODS

The present experiment entitled "Influence of different levels of nitrogen and spacing on growth, yield and quality of garlic (*Allium sativum* L.) cv. G-1" was carried out to assess the influence of nitrogen and spacing on growth yield and quality of garlic at the Research Farm, school of Agricultural Sciences, Department of Horticulture, Career Point University, Kota during the year 2019-20. The soil of experimental field was vertisols and soil pH is 7.68, Electrical conductivity is 0.49 dsm^{-1} and Organic carbon (%) 0.37 (Piper, 1950). The field was thoroughly prepared and the full doses of phosphorous and potassium in the form of SSP and MOP were applied at time of planting and Urea (46% N) used for source of nitrogen. Application of nitrogen as basal dose at the time of planting in half amount. The remaining dose of nitrogen was top dressed twice at 30 and 45 days after planting. The experiment consisted of Thirtysix treatment combinations with three levels of nitrogen (60, 100, 140 kg ha^{-1}) and three types of spacing (10×10, 15×10, 20×10 cm) was laid out in a Randomized Block design (Factorial) with four Replications. The experiment comprises of different levels of nitrogen and spacing i.e. T_1 N_1S_1-60kg N +10×10cm spacing,T_2 N_2S_1-100kg N + 10×10cm spacing,T_3 N_3S_1-140 kg N + 10×10cm spacing,T_4 N_1S_2-60 kg N + 15×10cm spacing,T_5 N_2S_2-100 kg N + 15×10cm spacing,T_6 N_3S_2-140 kg N + 15×10cm spacing,T_7 N_1S_3-60 kg N + 20×10cm spacing,T_8 N_2S_3-100 kg N + 20×10cm spacing, T_9 N_3S_3 -140 kg N + 20×10cm spacing. The observations recorded on 11 characters under growth and yield and 1 of quality in garlic i.e. plant height (cm), number of leaves of per plant, width of leaves, length of leaves, width of bulb, no. of cloves, weight of bulbs, weight of cloves etc. at 90DAP.

RESULTS AND DISCUSSION

Growth parameters

The observation recorded on germination (15 days after planting) of garlic as influenced by both factors viz., nitrogen and spacing (Table No.1 and Table No.2). Maximum germination (92.88%) was observed in the treatment of 140 kg N ha^{-1} (N_3) while lowest germination

(85.17%) was observed in the treatment of 60 kg N ha^{-1} (N_1). Spacing of 20×10 (S_3) recorded maximum germination (92.24%) while lowest germination was observed in the treatment 10× 10 S_1 (85.69%).

Maximum plant height 57.05cm at 90DAP respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest plant height 52.92 cm at 90DAP respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) 54.92 cm plant height was recorded. Levels of nitrogen showed positive effect on number of leaves/plant.

Maximum No. of leaves 8.49 90DAP respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest No. of leaves 7.64 at 90DAP respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) 8.03 No. of leaves was recorded Dixit (1997).

Maximum length of leaves 49.47cm at 90DAP respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest length of leaves 46.34 cm at 90DAP respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) 47.95 cm length of leaves was recorded.

Maximum width of leaves 1.82 cm at 90DAP respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest width of leaves 1.64 cm at 90DAP respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) 1.71 cm width of leaves was recorded. The significant influence of different levels of nitrogen and spacing was obtained in case of plant height, number of leaves, length and width of leaves at every stage. The boosted vegetative growth due to increased nutrients may be due to vegetative growth promotion favourably affecting photosynthesis and partitioning of assimilates. The remarkable increase in plant growth due to highest dose of nitrogen may be result of acceleration of cell elongation and cell division.

Yield parameter

Maximum weight of bulb per plant (35.42gm.) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest weight of bulb per plant (28.65gm) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (30.13 gm) weight of bulb per plant was recorded(Table No.3).

Maximum width of bulb (4.40 cm) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest width of bulb (3.81 cm) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (4.29 cm) weight of bulb per plant was recorded.

Maximum No. of cloves per bulb (26.88) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest No. of cloves per bulb (21.37) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (23.52) No. of cloves per bulb was recorded

Maximum bulb yield per plot (kg ha^{-1}) (3.55 kg) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest bulb yield per plot (kg ha^{-1}) (2.84 kg) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (3.21 kg) bulb yield per plot (kg ha^{-1}) was recorded.

Maximum bulb yield (q ha^{-1}) (111.12 q) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest bulb yield (q ha^{-1}) (79.36 q) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (97.58 q) bulb yield (q ha^{-1}) was recorded (Singh et al., 2017)

Maximum weight of 25 cloves (30.40 gm) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest weight of 25 cloves (21.91 gm) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (28.66 gm) weight of 25 cloves was recorded (Farooqui, 2008).

Quality parameter

Maximum TSS (32.93 %) after harvesting respectively was recorded with application of 140 kg N ha^{-1} (N_3). Lowest TSS (30.65 %) after harvest respectively was recorded with application of 60 kg N ha^{-1} (N_1), whereas application of 100 kg N ha^{-1} (N_2) (32.27 %) bulb yield (q ha^{-1}) was recorded (Table No.4).

Performance of garlic crop is considerably affected by plant spacing when plant height, number of leaves, length and width of leaves were at their maximum. The magnitude of superiority of 20 cm spacing over its 15 and 10 cm in respect of these growth parameters under reference was significant while the difference between the 10 and 15 cm plant spacing were not very marked and encouraging. In case of plant height 20×10 cm plant spacing recorded significantly tallest plant as compared to 10×10 cm spacings (Narula, 2002).

Application of 140 kg N ha^{-1} along with 20×10 cm spacing (T_9) was found significantly superior over other treatments and gave maximum weight of bulb per plant (38.07 gm) followed by 140 kg N ha^{1} with 15×10 cm spacing (T_6). Weight of bulb is the main contributing factor to per hectare yield. The weight of bulb was significantly affected by different treatments. The highest diameter of bulb was annexed with 140 kg N ha^{1} + 20×10 cm spacing which was significantly more than rest of the treatments. Similar results were reported by Viloria et al. (2003).

Application of 140 kg N ha^{-1} along with 20×10 cm spacing proved better than other application of nitrogen and spacings. This applied dose of nitrogen with wide spacing gave almost identical number of cloves per bulb (27.85), it was significantly higher than other treatments. This might be due to the increased level of nutrients and judicious spacing which ultimately resulted into large number of cloves per bulb (Singh & Gupta, 2001)

Economics

The maximum net return benefit cost ratio was obtained by the treatment 140 kg N + 20×10 cm spacing (4.75-T_9). The lowest benefit cost ratio (2.14- T_1) was found with the treatment 60 kg N + 10×10 cm spacing. These differences may be appear due to the different levels of nitrogen and different spacings. A minimum net monetary return of Rs.72100 per hectare was obtained when 60 kg N/ha with spacing of 10×10 cm was applied and that net monetary return reached to its maximum amounting Rs.164896 per hectare in plots where 140 kg N/ha with 20×10 cm spacing were used.

Table 1: Growth parameters influenced by different levels of nitrogen and spacing

Nitrogen levels(kg/ha)	Spacing Plant height 90DAP				Nitrogen levels(kg/ha)	Spacing No. of leaves 90DAP				Nitrogen levels(kg/ha)	Spacing Length of leaves 90DAP			
	S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN
N_1	50.40	53.70	54.67	52.92	N_1	6.85	7.87	8.20	7.64	N_1	44.65	48.15	46.15	46.31
N_2	50.95	54.86	58.96	54.92	N_2	7.90	8.00	8.20	8.03	N_2	45.52	48.31	50.02	47.95
N_3	52.80	55.25	63.10	57.05	N_3	8.05	8.59	8.85	8.49	N_3	47.82	49.44	51.15	49.47
MEAN	51.38	54.60	58.91		MEAN	7.60	8.15	8.41		MEAN	46.00	48.63	49.10	
	CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±
N	1.432		0.690	0.488	N	0.288		0.139	0.098	N	1.148		0.553	0.391
S	1.432		0.690	0.488	S	0.288		0.139	0.098	S	1.148		0.553	0.391
N×S	2.480		1.194	0.845	N×S	0.498		0.240	0.170	N×S	1.988		0.957	0.677

Table 2: Growth parameters influenced by different levels of nitrogen and spacing

Nitrogen levels(kg/ha)	Spacing Width of leaves 90DAP				Nitrogen levels(kg/ha)	Spacing Weight of bulb per plant				Nitrogen levels(kg/ha)	Spacing Width of bulb(cm)			
	S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN
N_1	1.52	1.80	1.61	1.64	N_1	26.10	28.97	30.87	28.65	N_1	3.12	3.97	4.33	3.81
N_2	1.75	1.67	1.72	1.71	N_2	30.07	27.96	32.35	30.13	N_2	4.10	4.35	4.44	4.29
N_3	1.71	1.75	2.02	1.82	N_3	32.35	35.85	38.07	35.42	N_3	4.27	4.45	4.49	4.40
MEAN	1.66	1.74	1.78		MEAN	29.50	30.93	33.76		MEAN	3.83	4.26	4.42	
	CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±
N	0.091		0.044	0.031	N	1.222		0.588	0.588	N	0.129		0.062	0.044
S	0.091		0.044	0.031	S	1.222		0.588	0.588	S	0.129		0.062	0.044
N×S	0.157		0.076	0.053	N×S	2.116		1.019	1.019	N×S	0.223		0.107	0.076

Table 3: Yield parameters influenced by different levels of nitrogen and spacing

Nitrogen levels(kg/ha)	Spacing Bulb yield per plot(kg)				Nitrogen levels(kg/ha)	Spacing Bulb yield per plot(qtl/ha)				Nitrogen levels(kg/ha)	Spacing No. of cloves per bulb			
	S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN
N_1	2.72	2.80	3.00	2.84	N_1	70.45	77.90	89.75	79.36	N_1	20.60	21.39	22.13	21.37
N_2	2.75	3.21	3.69	3.21	N_2	76.72	100.17	115.85	97.58	N_2	21.39	23.02	26.15	23.52
N_3	3.15	3.45	4.05	3.55	N_3	92.35	107.97	133.05	111.12	N_3	25.35	27.45	27.85	26.88
MEAN	2.87	3.15	3.58		MEAN	79.84	95.35	112.88		MEAN	22.44	23.95	25.38	
C.D 5%					C.D 5%					C.D 5%				
	CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±		CD(P=0.05)		SE(d)	S.E.M±
N	0.162		0.078	0.055	N	2.357		1.135	0.803	N	0.879		0.423	0.299
S	0.162		0.078	0.055	S	2.357		1.135	0.803	S	0.879		0.423	0.299
N×S	0.280		0.135	0.095	N×S	4.082		1.966	1.390	N×S	1.523		0.734	0.519

Table 4: Yield and Quality parameters influenced by different levels of nitrogen and spacing

Nitrogen levels(kg/ha)	Spacing Weight of 25 cloves				Nitrogen levels(kg/ha)	Spacing TSS%			
	S_1	S_2	S_3	MEAN		S_1	S_2	S_3	MEAN
N_1	20.60	22.13	23.02	21.91	N_1	28.28	31.67	32.90	30.95
N_2	22.13	30.50	33.35	28.66	N_2	31.12	32.35	33.35	32.27
N_3	23.02	32.35	35.85	30.40	N_3	30.87	32.87	35.05	32.93
MEAN	21.91	28.32	30.74		MEAN	30.09	32.30	33.76	
	CD(P=0.05)	SE(d)	S.E.M±			CD(P=0.05)	SE(d)	S.E.M±	
N	1.123	0.541	0.382		N	0.906	0.436	0.308	
S	1.123	0.541	0.382		S	0.906	0.436	0.308	
N×S	1.944	0.936	0.662		N×S	NS	0.756	0.534	

Acknowledgments

I would like to express my very great appreciation to Mr. Mukesh Kumar and Ms. Asha Nama for his valuable and constructive suggestions during the planning and development of this research work.

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